Observation of Coherent Exclusive ρ^0 Production in Ultra-Peripheral Relativistic Heavy Ion Collisions

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We present the first observation of coherent ρ^0 production in ultra-peripheral relativistic heavy ion collisions. At impact parameters $b > 2R_A$ the nuclei do not physically collide, but interact via long-range electromagnetic fields. Two photo-nuclear processes are observed at STAR: exclusive ρ^0 production, $AuAu \rightarrow AuAu\rho^0$, and ρ^0 production with accompanying nuclear excitation, $AuAu \rightarrow Au^\star Au^\star \rho^0$. To study the later process, a data set of about 800k 'minimum bias' events at $\sqrt{S_{NN}} = 130$ GeV/nucleon is used, where the coincident detection of neutrons from nuclear break up in the zero degree calorimeters is required as a trigger.

Events were selected with exactly two tracks that formed a primary vertex. The pair transverse momentum spectrum in Fig. 1a) is peaked at $p_T \sim 50$ MeV, which is the signature for coherent coupling to both nuclei. [1] A normalized background model from like-sign combination pairs (histogram) does not show such a peak.

The acceptance and efficiency corrected $M_{\pi\pi}$ invariant mass spectrum of Fig. 1b shows a clear peak at the ρ^0 mass for the coherent events with a pair $p_T < 150$ MeV. The shaded histogram is the combinatorial background; the hashed histogram contains additionally the contribution from coherent e^+e^- pairs. [2] The spectrum is fitted (solid line) by a relativistic Breit-Wigner for the ρ, a mass-independent contribution from direct $\pi^+\pi^-$ production (both dashed), and their interference. [3] A polynomial contribution for the background (dash-dotted) is included in the fit. The ρ^0 mass and width are consistent with the known values. The amplitude ratio of direct pion pair to ρ production is comparable to photon-proton scattering data. Preliminary, the cross section for coherent ρ^0 production accompanied by nuclear excitation $\sigma(AuAu \rightarrow Au^*_{xn}Au^*_{xn}\rho^0)$ is of order 30 mb and the cross section for ρ^0 production with nuclear breakup under emission of single neutrons $\sigma(AuAu \rightarrow Au^*_{1n}Au^*_{1n}\rho^0)$ is of order 2 mb. Here, the nuclear excitation is dominated by the Giant Dipole Resonance.

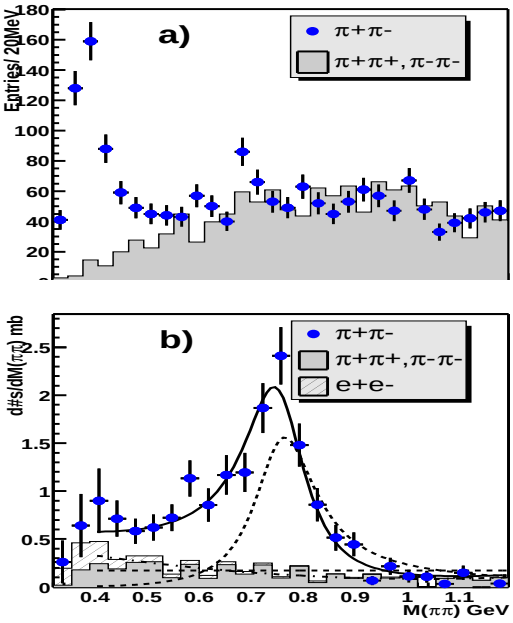

Figure 1: (a) The p_T distribution for ρ candidates from the minimum bias data sample. (b) The $M_{\pi\pi}$ invariant mass distribution for $p_T < 0.15$ GeV/c.

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